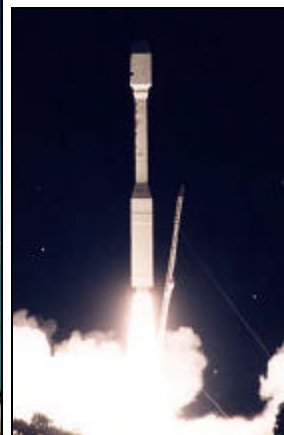




*Associate Administrator for
Commercial Space Transportation (AST)*

January 1999

COMMERCIAL SPACE TRANSPORTATION: 1998 YEAR IN REVIEW



Cover Photo Credits (from left):

International Launch Services (1998). Image is of the Atlas 2AS launch on June 18, 1998, from Cape Canaveral Air Station. It successfully orbited the Intelsat 805 communications satellite for Intelsat.

Boeing Corporation (1998). Image is of the Delta 2 7920 launch on September 8, 1998, from Vandenberg Air Force Base. It successfully orbited five Iridium communications satellites for Iridium LLP.

Lockheed Martin Corporation (1998). Image is of the Athena 2 awaiting its maiden launch on January 6, 1998, from Spaceport Florida. It successfully deployed the NASA Lunar Prospector.

Orbital Sciences Corporation (1998). Image is of the Taurus 1 launch from Vandenberg Air Force Base on February 10, 1998. It successfully orbited the Geosat Follow-On 1 military remote sensing satellite for the Department of Defense, two Orbcomm satellites and the Celestis 2 funerary payload for Celestis Corporation.

Orbital Sciences Corporation (1998). Image is of the Pegasus XL launch on December 5, 1998, from Vandenberg Air Force Base. It successfully orbited the Sub-millimeter Wave Astronomy Satellite for the Smithsonian Astrophysical Observatory.

INTRODUCTION

In 1998, U.S. launch service providers conducted 22 launches licensed by the Federal Aviation Administration (FAA), an increase of 29 percent over the 17 launches conducted in 1997. Of these 22, 17 were for commercial or international customers, resulting in a 47 percent share of the world's market for commercial launches. Revenues from the FAA-licensed space launches surpassed the \$1 billion mark for the first time in 1998, reaching \$1,119 million, an increase of 19 percent over 1997 revenues of \$940 million. Over the past five years, revenues have increased by more than a factor of three, up from \$353 million in 1994.

In 1998, the FAA amended existing launch operator licenses to include the new Delta 3 and Atlas 3A and 3B launch vehicles. In addition, the FAA issued its fourth launch site operator license to the Alaska Aerospace Development Corporation to operate a launch site at Kodiak Island, Alaska.

In addition, 1998 saw continuing demand for launches to deploy the world's first low Earth orbit (LEO) communication systems. In 1998, there were 17 commercial launches to LEO, 14 of which were for the Iridium, Globalstar, and Orbcomm LEO communications constellations. There were 19 commercial launches to geostationary orbit (GEO). A total of 82 commercial payloads were placed in LEO, 78 of which were for communications systems. There were 22 commercial GEO payloads launched.

Commercial Space Transportation: 1998 Year in Review summarizes U.S. and international launch activities for calendar year 1998 and provides a historical look at the past five years of commercial launch activities. This report has three parts:

- 1998 FAA-Licensed Commercial Activity
- 1998 Worldwide Launch Activity
- Five-Year Space Transportation Trends

ABOUT THE ASSOCIATE ADMINISTRATOR FOR COMMERCIAL SPACE TRANSPORTATION (AST)

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) licenses and regulates U.S. commercial space launch activity as authorized by Executive Order 12465, *Commercial Expendable Launch Vehicle Activities*, and the *Commercial Space Launch Act of 1984*, as amended. AST's mission is to regulate the U.S. commercial launch industry; license commercial launch operations to ensure public health and safety and the safety of

property; and protect national security and foreign policy interests of the United States during commercial launch operations. In addition, the *Commercial Space Launch Act of 1984* and the *1996 National Space Policy* directs the Federal Aviation Administration to encourage, facilitate, and promote commercial space launches. Additional information concerning space transportation can be found on AST's web site, at <http://ast.faa.gov>.

1998 FAA-LICENSED LAUNCH SUMMARY

In 1998, U.S. launch providers conducted 22 launches licensed by the Federal Aviation Administration's (FAA) Office of the Associate Administrator for Commercial Space Transportation (AST) (Table 1), an increase of 29 percent over 1997 (Figure 1). Of the 22 FAA-licensed launches, 17 were conducted for commercial or international customers and five were conducted for U.S. Government agencies.¹ Licensed launches accounted for 61 percent of the United States' 36 launches in 1998, which also includes government launches of the Space Shuttle and other civil and military payloads.

Licensed-Launch Revenues Exceed \$1 Billion

Revenues from the 22 FAA-licensed launches reached \$1,119 million in 1998, a 19 percent increase over 1997 revenues of \$940 million. This was the first time revenues from FAA-licensed launches have surpassed \$1 billion (Figure 2). Revenues for the 17 commercial launches conducted in 1998 totaled \$911 million.

LEO Market Growth Continues

Launches to low Earth orbit (LEO) continued to fuel growth of the U.S. commercial space transportation industry in 1998. Of the 17 commercial launches conducted, 10 placed spacecraft in low Earth orbit and seven were to geostationary transfer orbit (GTO). Commercial launches to LEO included seven Delta 2 launches deploying 25 Iridium and eight Globalstar satellites, and two Pegasus launches deploying 16 Orbcomm satellites. Two of five government launches licensed by the FAA were to LEO and both carried commercial spacecraft as secondary

Figure 1. FAA-Licensed Orbital Launch Events

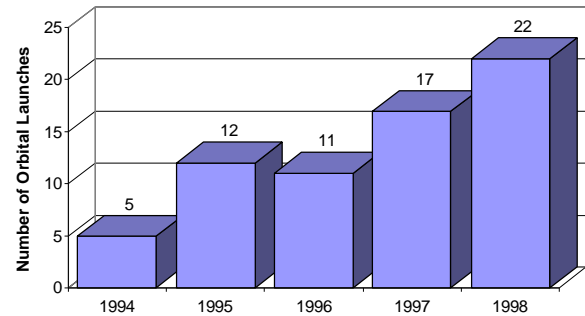


Figure 2. Revenues for FAA-Licensed Orbital Launch Events (in U.S. millions)

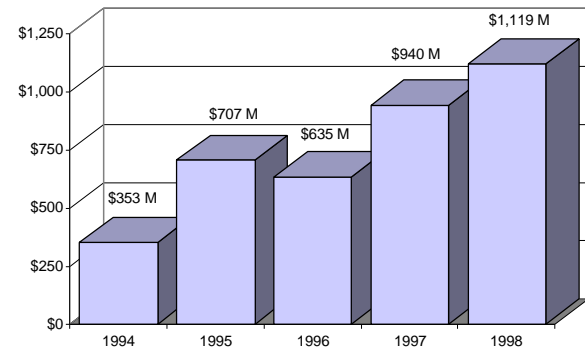


Table 1. 1998 FAA-Licensed Orbital Launch Events

Date	Vehicle	Payload	Govt/Coml	Launch Outcome	Orbit
Jan. 6	Athena 2	Lunar Prospector*	Govt	Success	Lunar
Jan. 9	Delta 2	Skynet 4D	Coml	Success	GEO
Feb. 10	Taurus	Geosat Follow-On* Orbcomms 3, 4 [†] Celestis-2	Govt	Success	LEO
Feb. 14	Delta 2	Globalstars 1-4	Coml	Success	LEO
Feb. 18	Delta 2	Iridiums 50, 52-54, 56	Coml	Success	LEO
Feb. 25	Pegasus	SNOE* Teledesic T1	Govt	Success	LEO
Feb. 27	Atlas 2AS	Intelsat 8A F6	Coml	Success	GEO
Mar. 16	Atlas 2	GBS 8*	Govt	Success	GEO
Mar. 29	Delta 2	Iridiums 55, 57-60	Coml	Success	LEO
Apr. 24	Delta 2	Globalstars 6, 8, 14, 15	Coml	Success	LEO
May 17	Delta 2	Iridiums 70, 72-75	Coml	Success	LEO
Jun. 9	Delta 2	Thor 3	Coml	Success	GEO
Jun. 18	Atlas 2AS	Intelsat 8A F5	Coml	Success	GEO
Aug. 2	Pegasus	Orbcomms 13-20 [†]	Coml	Success	LEO
Aug. 26	Delta 3	Galaxy 10	Coml	Failure	GEO
Sep. 8	Delta 2	Iridiums 77, 79-82	Coml	Success	LEO
Sep. 23	Pegasus	Orbcomms 21-28 [†]	Coml	Success	LEO
Oct. 9	Atlas 2AS	Hot Bird 5	Coml	Success	GEO
Oct. 20	Atlas 2A	GBS 9*	Govt	Success	GEO
Oct. 22	Pegasus	SCD 2	Coml	Success	LEO
Nov. 6	Delta 2	Iridiums 83-87	Coml	Success	LEO
Nov. 22	Delta 2	Bonum 1	Coml	Success	GEO

* U.S. Government payload; launch services not internationally competed.

[†] Commercial payload; launch services not internationally competed.

¹ As part of its licensing of commercial launches, the FAA licenses launches commercially procured by the U.S. Government; for purposes of this report, however, a "commercial launch" is defined as a launch that is internationally competed, i.e. available in principle to international launch providers, or whose primary payload is commercial in nature. U.S. Government launches procured commercially are considered to be government launches.

payloads. Launches to GTO dominated the commercial market until the deployment of LEO constellations began in 1997.

100th FAA-Licensed Launch Conducted

The one-hundredth FAA-licensed launch was conducted on September 8, 1998, when a Boeing Delta 2 launched five Iridium spacecraft from Vandenberg Air Force Base, California. The first 50 launches occurred over six years, from March of 1989 to August of 1995, while the next 50 took just three years. A total of 106 licensed launches have been conducted through end-1998.

New Launch Vehicles Fail, Delay

Despite a record year, U.S. launch providers encountered several setbacks in the development of new launch vehicles. The debut of Boeing's Delta 3 ended in failure on August 26 when an unexpected roll mode forced destruction of the vehicle during its maiden flight. The inaugural flights of both the Boeing-led Sea Launch and Lockheed Martin's Atlas 3 were postponed from 1998 into 1999 as development efforts continue.

Launch and Site Operator Licensing Actions

In 1998, the FAA amended existing launch operator licenses to include the new Delta 3 and Atlas 3A and 3B launch vehicles. In addition, the FAA issued its fourth launch site operator license to the Alaska Aerospace Development Corporation to operate a launch site at Kodiak Island, Alaska. The FAA has also issued launch site operator licenses for Spaceport Florida at Cape Canaveral Air Station, Florida, the California Spaceport, located at Vandenberg Air Force Base, California, and the Virginia Space Flight Center at Wallop's Island, Virginia.

Other U.S. Launch Activities

A total of 36 launches were conducted by nine launch vehicle families in 1998 (see Table 2). In addition to the failure of Boeing's Delta 3, the U.S. suffered another launch failure on August 12 when a Titan 4 carrying a classified NRO payload experienced a power failure causing the vehicle to pitch over and break apart. Also, the successful first launch of the Athena 2 was conducted by Lockheed Martin on January 6.

Table 2. United States Launch Vehicle Performance in 1998

Vehicle	Pegasus	Taurus	Athena 2	Titan 2	Delta 2	Delta 3	Atlas 2	Shuttle	Titan 4
1998 Total Launches	6	2	1	1	12	1	6	5	2
Licensed Launches	4	1	1	0	10	1	5	0	0
Reliability 1998	6/6 (100%)	2/2 (100%)	1/1 (100%)	1/1 (100%)	12/12 (100%)	0/1 (0%)	6/6 (100%)	5/5 (100%)	1/2 (50.0%)
Last 10 Years	22/25 (88.0%)	3/3 (100%)	1/1 (100%)	6/6 (100%)	76/77 (98.7%)	0/1 (0%)	48/50 (96.0%)	67/67 (100%)	23/25 (92.0%)
First Launch	1990	1994	1998	1964	1989	1998	1991	1981	1989
Launch Sites	VAFB, Wallops	VAFB	CCAS, VAFB	VAFB	CCAS, VAFB	CCAS	CCAS, VAFB	KSC	CCAS, VAFB
LEO (lb./28.5°/100 nm)	1,015	3,300	4,350	7,900	11,220	18,280	19,050	47,300	47,800
GTO (lb.)	--	1,290	--	--	4,060	8,400	8,200	13,000	19,000

1998 WORLDWIDE LAUNCH ACTIVITY

A total of 36 commercial launches were conducted worldwide in 1998 by launch providers in five countries. The United States captured 47 percent of the commercial launch services market, conducting 17 commercial launches. Foreign launch providers conducted 19 commercial launches, led by Europe's Arianespace with nine launches for a 25 percent market share and Russia with five launches for a 14 percent market share (Figures 3-4, Tables 3-4). A total of 82 orbital launches were conducted worldwide in 1998 for commercial, civil, and military purposes (see Appendix).

Worldwide Commercial Launch Revenues

Revenues from the 36 commercial launches conducted globally in 1998 reached an estimated \$2.1 Billion.² U.S. revenues were \$911 million, or 43 percent, followed by Europe with \$763 million, Russia with \$313 million, China with \$90 million, and Ukraine with about \$35 million.

Table 3. 1998 Non-U.S. Commercial Launch Events

Date	Vehicle	Payload	Launch Outcome	Orbit
Feb. 4	Ariane 44LP	Inmarsat 305 Brazilsat B3	Success	GEO
Feb. 27	Ariane 42P	Hot Bird 4	Success	GEO
Mar. 25	Long March 2C	Iridiums 51, 61	Success	LEO
Apr. 7	Proton	Iridiums 62-68	Success	LEO
Apr. 28	Ariane 44P	BSAT 1B Nilesat 101	Success	GEO
May 2	Long March 2C	Iridiums 69, 71	Success	LEO
May 8	Proton	EchoStar 4	Success	GEO
Jul. 7	Shtil 1	Tubsat N & N1	Success	LEO
Aug. 20	Long March 2C	Iridiums 3, 76	Success	LEO
Aug. 25	Ariane 44P	ST 1	Success	GEO
Aug. 30	Proton	Astra 2A	Success	GEO
Sep. 10	Zenit 2	Globalstars 5,7,9-13, 16-20	Failure	LEO
Sep. 16	Ariane 44LP	PAS 7	Success	GEO
Oct. 5	Ariane 44L	Eutelsat W2 Sirius 3	Success	GEO
Oct. 28	Ariane 44L	AfriStar 1 GE 5	Success	GEO
Nov. 4	Proton	PAS 8	Success	GEO
Dec. 4	Ariane 42L	SatMex 5	Success	GEO
Dec. 19	Long March 2C	Iridiums 92, 93	Success	LEO
Dec. 21	Ariane 42L	PAS 6B	Success	GEO

² Revenues for both U.S. and foreign commercial launches are based on open source information and estimates by AST and are approximations only.

Figure 3. 1998 Total Worldwide Launch Activity

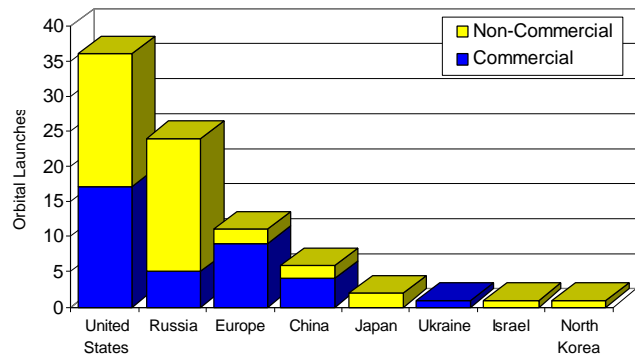


Table 4. 1998 Orbital Launch Events

	Commercial Launches	Non-Commercial Launches	TOTAL Launches
United States	17	19	36
Russia	5	19	24
Europe	9	2	11
China	4	2	6
Japan	0	2	2
Ukraine	1	0	1
Israel	0	1	1
North Korea	0	1	1
TOTAL	36	46	82

Figure 4. 1998 Worldwide Commercial Market Share

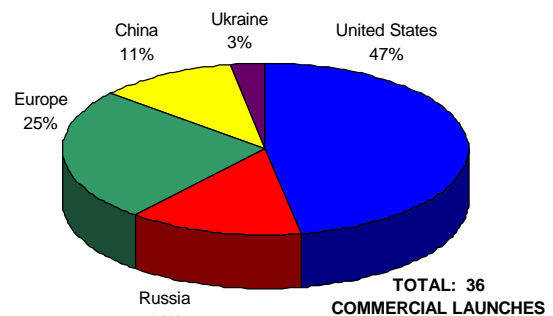
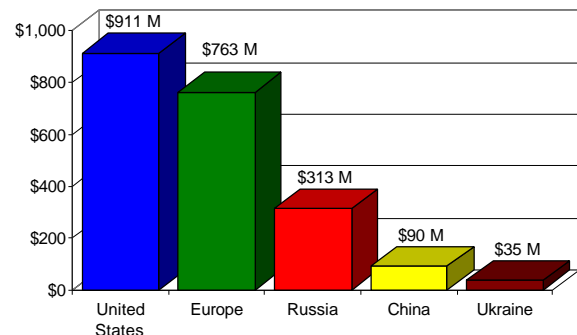


Figure 5. 1998 Commercial Launch Revenues (approximate)



Vehicle, Spacecraft Problems Forestall Growth

Commercial launch activity in 1998 was just shy of the record 37 launches in 1997 due to both launch vehicle and satellite failures. Russia's Proton was grounded for three months following a failure in December 1997, and the Delta 3 failure on its maiden launch in August 1998 kept it from conducting additional flights. At the same time, several satellites experienced on-orbit failures, such as Galaxy 4, and other problems produced spacecraft delays on the ground.

Worldwide Payload Summary

A total of 167 spacecraft were launched on 82 launches in 1998, an 11 percent increase over the 150 payloads launched in 1997. Of these 167, 104 were for commercial purposes and 63 were for governmental or scientific purposes.³ Four government payloads and 13 commercial payloads failed to reach orbit due to launch failures, including the loss of 12 Globalstar spacecraft when a Zenit failed on September 10. There were 22 commercial payloads launched to GEO. There were 19 commercial launches to GEO and 17 commercial launches to LEO, with some commercial payloads launched as secondary payloads on government launches.

Commercial LEO Payloads Dominate

The deployment of LEO telecommunications constellations continued to dominate commercial payloads in 1998, with 82 out of the 104 commercial payloads launched going to LEO, including 78 spacecraft for the Iridium, Globalstar, and Orbcomm systems. Other commercial payloads launched to LEO include the Teledesic T-1 experimental communications

Figure 6. 1998 Total Worldwide Launch Activity

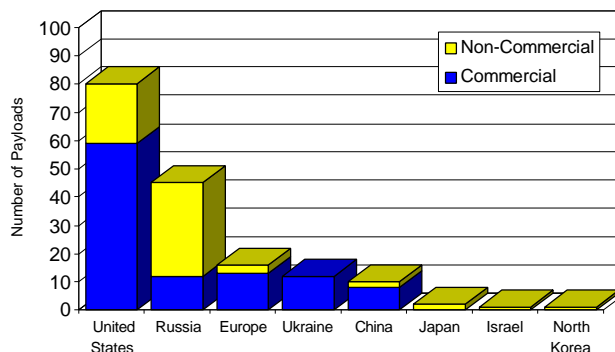


Table 5. Payloads Launched in 1998

	Commercial Payloads	Non-Commercial Payloads	TOTAL Payloads
United States	59	21	80
Russia	12	33	45
Europe	13	3	16
China	8	2	10
Ukraine	12	0	12
Japan	0	2	2
Israel	0	1	1
North Korea	0	1	1
TOTAL	104	63	167

Figure 8. Payloads Launched by Country in 1998

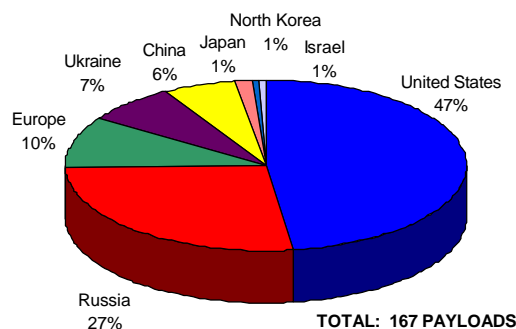
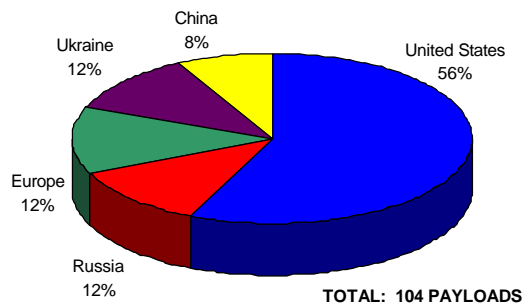


Figure 7. Commercial Payloads Launched by Country in 1998



³ The term "commercial payload" refers to a spacecraft which serves a commercial function or is operated by a commercial entity, without regard to how it was launched. For this report, communications satellites launched for international consortia such as Intelsat are considered commercial. Satellites for government communications purposes may or may not be considered commercial, depending on the percent of capacity leased to commercial operators.

spacecraft, the Thai Tmsat-1 and Russian SPIN-2 remote sensing spacecraft, and a Celestis space burial capsule for a of total 82 LEO payloads.

Launch Activities by Country

Russia – In 1998, Russian companies continued to play an important role in providing commercial launch services to the international satellite market. However, due to the failure of the Proton at the end of 1997 and delays in many satellite programs, the number of commercial launches conducted by Russia decreased to five in 1998, down from seven in 1997. Russia conducted four commercial Proton launches and one launch of a converted submarine-launched ballistic missile. In 1998, Russia conducted a total of 24 government and commercial launches for 29 percent of the world's total launches.

Of the four commercial Proton missions, three were contracted through U.S.-based International Launch Services (ILS), a marketing partnership between Lockheed Martin and Proton's Russian manufacturers, Khrunichev and Energia.

Russia's only non-Proton commercial launch in 1998 was that of the Shtil converted SS-N-23 submarine-launched ballistic missile (SLBM). Shtil was launched from the Novomoskovsk submarine in the Barents Sea on July 7 carrying the Tubsat N and N1 small satellites for the Technical University of Berlin.

Ukraine – Ukraine conducted its first commercial launch in 1998, which was a failure. On September 10, 1998, a Ukrainian Zenit launch vehicle failed shortly after launch from Baikonur, destroying 12 Globalstar satellites. The first of three planned Zenit launches for Globalstar, the failure resulted in the cancellation of the remaining two launches. Zenit was also launched on Russian government missions, conducting two successful launches in 1998, one carrying five small secondary payloads.

Europe – Europe's Ariespace conducted nine commercial Ariane 4 launches in 1998, placing in orbit 13 geostationary telecommunications spacecraft. These nine launches were worth approximately \$750 million in revenues for

Table 6. Russian and Ukrainian Launch Vehicle Performance in 1998

	RUSSIA & UKRAINE						
Vehicle	Shtil-1N	Cosmos	Cyclone-3	Molniya	Soyuz	Zenit-2	Proton
1998 Total Launches	1	2	1	3	8	3	7
Reliability 1998	1/1 (100%)	2/2 (100%)	1/1 (100%)	3/3 (100%)	8/8 (100%)	2/3 (66.7%)	7/7 (100%)
Last 10 Years	1/1 (100%)	61/62 (98.4%)	42/44 (95.5%)	55/55 (100%)	184/187 (98.4%)	13/18 (72.2%)	84/89 (94.4%)
First Launch	1998	1964	1977	1961	1963	1985	1967
Launch Sites	Submarine launched	Plesetsk	Plesetsk	Baikonur, Plesetsk	Baikonur, Plesetsk	Baikonur	Baikonur
LEO (lb.)	950	3,100	8,820	3,970 (polar)	15,400	30,300	44,200
GTO (lb.)	--	--	--	--	--	--	10,150

Arianespace and represent 25 percent of 1998's 36 commercial launches conducted worldwide. Arianespace also conducted two government launches, one of the Spot 4 remote sensing spacecraft on an Ariane 4 and the third and final development launch of the new Ariane 5.

China – China conducted six launches in 1998, four commercial launches and two government launches. Each commercial launch placed two Iridium spacecraft into low Earth orbit on a Long March 2C rocket. China also conducted two Long March 3B launches of U.S. and European-manufactured geostationary spacecraft for use by the Chinese government. The future of Chinese commercial launch activities is unclear following allegations of technology transfer to China following two launch vehicle failures in 1996.

Japan – Japan conducted two launches in 1998, neither of which was commercial. The first was an unsuccessful launch of the COMETS experimental geostationary communications satellite on an H-2 rocket by Japan's National Space Development Agency (NASDA). The H-2

second stage failed, leaving the spacecraft in a useless orbit. The second launch was of an M-5, which launched the Nozomi spacecraft toward Mars. The M-5 is operated by Japan's Institute of Space and Astronautical Science (ISAS).

Israel – The Israel Space Agency conducted one launch in 1998, that of a Shavit which ended in failure on January 22, 1998. The vehicle failed during second stage flight, destroying the Ofeq 4 remote sensing spacecraft. In October, NASA awarded a contract to U.S.-based Coleman Research to provide launch services using a Shavit derivative dubbed LK-0.

North Korea – The Democratic People's Republic of North Korea (DPRK) surprised the world on August 31, 1998 with its first orbital launch attempt. North Korea maintains that the launch of the Taepo Dong-1 rocket orbited the Kwangmyongsong satellite; however, it was not detected in orbit. Although the launch ended in failure, it demonstrated a more sophisticated knowledge of ballistic missile technology than previously demonstrated.

Table 7. European, Chinese, Japanese, Israeli, and North Korean Launch Vehicle Performance in 1998

	EUROPE		CHINA		JAPAN		ISRAEL	NORTH KOREA
Vehicle	Ariane 4	Ariane 5	LM-2C	LM-3B	M-5	H-2	Shavit	Taepo Dong-1
1998 Total Launches	10	1	4	2	1	1	1	1
Reliability 1998	10/10 (100%)	1/1 (100%)	4/4 (100%)	2/2 (100%)	1/1 (100%)	0/1 (0%)	0/1 (0%)	0/1 (0%)
Last 10 Years	79/82 (96.3%)	2/3 (66.7%)	9/9 (100%)	4/5 (80.0%)	2/2 (100%)	5/6 (83.3%)	2/3 (66.7%)	0/1 (0%)
First Launch	1988	1996	1975	1996	1997	1994	1988	1998
Launch Sites	Kourou	Kourou	Xichang	Xichang	Kagoshima	Tanegashima	Palmachim AFB	Musudan-ri Firing Range
LEO (lb.)	21,100	39,600	7,040	29,900	5,500	23,000	350	unknown
GTO (lb.)	10,900	15,000	2,200	9,900	2,680	8,800	--	--

FIVE-YEAR SPACE TRANSPORTATION TRENDS

Over the past five years, the number of commercial launches worldwide has nearly tripled, from 14 in 1994 to 36 in 1998. Commercial launches represented a record 44 percent of worldwide launches in 1998. Commercial launches accounted for only 15 percent of worldwide launch activities just five years ago. Government launch activities have been on a steady decline since the end of the Cold War and the dissolution of the Soviet Union in 1991. Russia, which accounted for close to 100 launches a year in the late-1980s, conducted only 24 launches in 1998, dramatizing the vast reduction in military launch activity. Five of Russia's 24 launches were commercial.

Over the same period, worldwide commercial launch revenues have doubled from just over \$1 billion in 1994 to \$2.1 billion in 1998. Revenues were down from a high in 1997 of \$2.4 billion due to fewer launches to GEO in 1998. Revenues have grown at a slower pace than launches due to the increasing number of smaller launches to low

Figure 9. Launch Revenues for Commercial Launch Events (approximate, in U.S. millions)

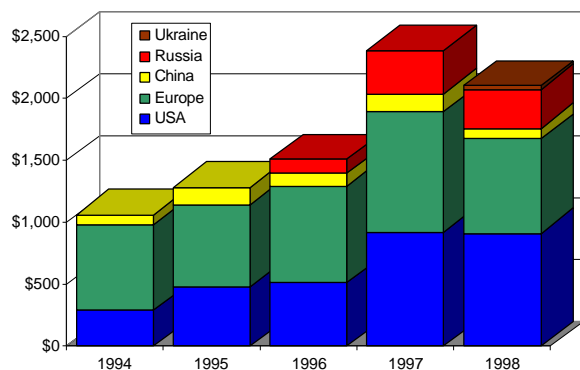
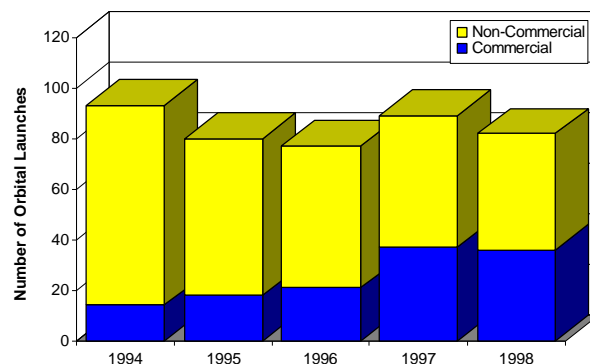


Table 8. Launch Revenues for Commercial Launch Events (approximate, in U.S. millions)

	1994	1995	1996	1997	1998
U.S.	\$288	\$481	\$510	\$923	\$911
Europe	\$693	\$664	\$788	\$970	\$763
China	\$83	\$142	\$95	\$148	\$90
Russia			\$120	\$351	\$313
Ukraine					\$35
TOTAL	\$1,064	\$1,287	\$1,513	\$2,392	\$2,112

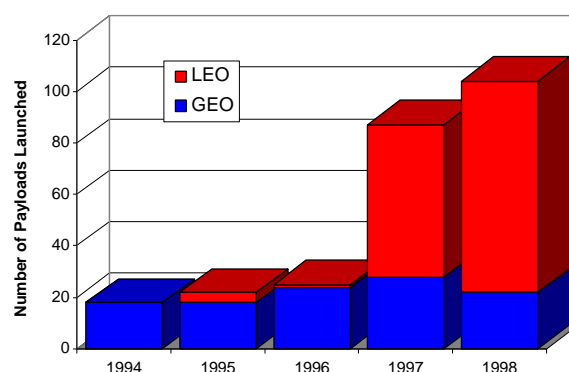
**Figure 10. Five-Year Summary (1994 – 1998)
Launches by Launch Event Type**



**Table 9. Five-Year Summary (1994 – 1998)
Launches by Launch Event Type**

	Commercial Launches	Non-Commercial Launches	TOTAL Launches
1994	14	79	93
1995	18	62	80
1996	21	56	77
1997	37	52	89
1998	36	46	82

**Figure 11. Five-Year Summary (1994 – 1998)
Commercial Payloads Launched, by Orbit**



**Table 10. Five-Year Summary (1994 – 1998)
Commercial Payloads Launched, by Orbit**

	GEO Commercial Payloads	LEO Commercial Payloads	Total Commercial Payloads
1994	18	0	18
1995	18	4	22
1996	24	1	25
1997	28	59	87
1998	22	82	104

Earth orbit, which result in lower revenues per launch than launches to geostationary orbit.

The number of payloads deployed has also jumped dramatically over the past five years as a result of the deployment of low Earth orbit satellite communications constellations (Figure 11, Table 10). Prior to 1997, virtually all commercial spacecraft were deployed to geostationary orbit. By contrast, in 1997 and 1998, 50 commercial spacecraft were launched to geostationary orbit while a total of 141 smaller commercial payloads were deployed to LEO.

In terms of overall launch activity for the period 1994 through 1998, the United States now holds the largest share of the world's launches with 39 percent, edging out Russian launch activity. The number of U.S. launches per year surpassed Russian launches in 1996 for the first time since 1967. A total of 10 countries have conducted space launches in the last five years.

U.S. launch providers lead the world in commercial market share conducting 42 percent of the commercial launches over the past five years. The United States has rapidly gained market share in the past two years as launches to low Earth orbit increased with the deployment of the Iridium, Globalstar, and Orbcomm LEO communications constellations. Europe has conducted only 13 percent of the world's total of launches, however, it has conducted 35 percent of the commercial launches conducted in the last five years. Europe's Arianespace has long dominated the commercial launch services market for launches to geostationary orbit, and continued to do so in 1998, conducting nine of the 19 commercial GEO launches, more than any other provider. Russia and China have both conducted 14 commercial launches for a market share of 11 percent. Russia, however, has contracted for a higher number of future launches than has China, using marketing arrangements with both Lockheed Martin and France's Arianespace and Aerospatiale.

Figure 12. Five-Year Worldwide Launch Totals (1994 – 1998)

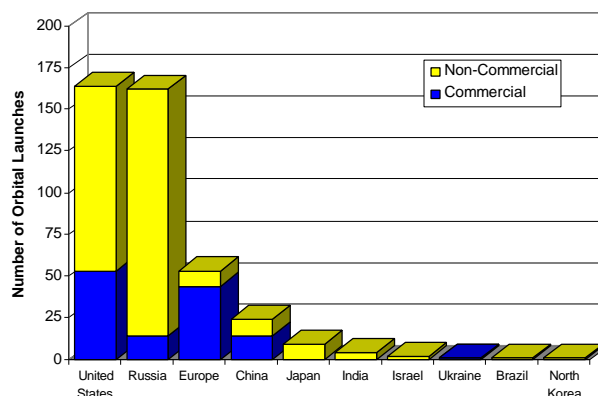


Table 11. Five-Year Worldwide Launch Totals (1994 – 1998)

	Commercial Launches	Non-Commercial Launches	TOTAL Launches
United States	53	111	164
Russia	14	148	162
Europe	44	9	53
China	14	10	24
Japan	0	9	9
India	0	4	4
Israel	0	2	2
Ukraine	1	0	1
Brazil	0	1	1
North Korea	0	1	1
TOTAL	126	295	421

Figure 13. Five-Year Worldwide Orbital Launch Share (1994 – 1998)

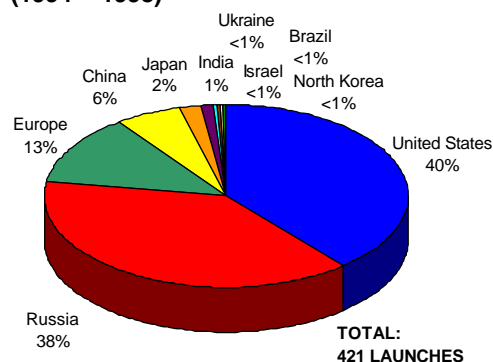
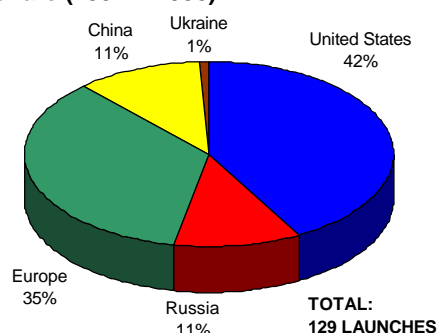


Figure 14. Five-Year Worldwide Commercial Launch Share (1994 – 1998)



1998 WORLDWIDE ORBITAL LAUNCH EVENTS

Date	Vehicle	Site	Payload	Operator	Manufacturer	Use	Coml Price	L	M
1/6/98	† Athena 2	Spaceport Florida	Lunar Prospector	NASA	Lockheed Martin	Scientific	\$21-28 M	S	S
1/9/98	v † Delta 2 7925	CCAS	Skynet 4D	British Defense Ministry	Matra Marconi	Communications	\$45-55 M	S	S
1/22/98	Shuttle Endeavour	KSC	STS 89	NASA	Rockwell International	Crewed		S	S
1/22/98	Shavit 1	Palmachim	Offeq 4	Israel Space Agency	Israel Aircraft Ind. (IAI)	Remote Sensing		F	F
1/29/98	Soyuz	Baikonur	Soyuz TM-27	RKK Energia	RKK Energia	Crewed		S	S
1/29/98	Atlas 2A	CCAS	SM II 98-01	DoD	Unknown	Intelligence		S	S
2/4/98	v Ariane 44LP	Kourou	* Brazilsat B3	Embratel	Hughes	Communications	\$80-95 M	S	S
			* Inmarsat 3 F5	Inmarsat	Lockheed Martin	Communications			
2/10/98	† Taurus 1	VAFB	Geosat Follow-On	DoD	Ball Aerospace	Remote Sensing	\$18-20 M	S	S
			* Celestis 2	Celestis	Celestis	Other			
			* Orbcomms 03-04	Orbcomm	Orbital (OSC)	Communications			
2/14/98	v † Delta 2 7420	CCAS	* Globalstars 1-4	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
2/17/98	Soyuz	Baikonur	* Spin 2	Sovinformspurnik	Central Specialized Design Bureau (TsSKB)	Remote Sensing		S	S
2/18/98	v † Delta 2 7920	VAFB	* Iridiums 50,52-56	Iridium, Inc.	Lockheed Martin	Communications	\$45-55 M	S	S
2/21/98	H 2	Tanegashima	COMETS 1	NASDA	Toshiba	Communications		F	F
2/25/98	† Pegasus XL	VAFB	SNOE	Univ. of Colorado/NASA	University of Colorado	Scientific	\$12-15 M	S	S
			* Teledesic T1	Teledesic	Orbital (OSC)	Communications			
2/27/98	v † Atlas 2AS	CCAS	* Intelsat 8A F6	New Skies Satellites	Lockheed Martin	Communications	\$90-105 M	S	S
2/27/98	v Ariane 42P	Kourou	* Hot Bird 4	Eutelsat	Matra Marconi	Communications	\$60-75 M	S	S
3/15/98	Soyuz	Baikonur	Progress M-38	RKK Energia	RKK Energia	Mir Re-supply		S	S
3/16/98	† Atlas 2	CCAS	GBS 8	DoD	Hughes	Communications	\$62-85 M	S	S
3/23/98	Ariane 40	Kourou	SPOT 4	CNES	Matra Marconi	Remote Sensing		S	S
3/25/98	v Long March 2C	Taiyuan	* Iridiums 51, 61	Iridium, Inc.	Lockheed Martin	Communications	\$20-25 M	S	S
3/29/98	v † Delta 2 7920	VAFB	* Iridiums 55, 57-60	Iridium, Inc.	Lockheed Martin	Communications	\$45-55 M	S	S
4/1/98	Pegasus XL	VAFB	TRACE	NASA	NASA	Scientific		S	S
4/7/98	v Proton	Baikonur	* Iridiums 62-68	Iridium, Inc.	Lockheed Martin	Communications	\$75-95 M	S	S
4/17/98	Shuttle Columbia	KSC	STS 90	NASA	Rockwell International	Crewed		S	S
4/24/98	v † Delta 2 7420	CCAS	* Globalstars 6,8,14,15	Globalstar, Inc.	Space Systems/Loral	Communications	\$45-55 M	S	S
4/28/98	v Ariane 44P	Kourou	* BSAT 1 B	Broadcast Satellite Sys.	Hughes	Communications	\$70-85 M	S	S
			* Nilesat 101	Egypt Radio/TV Union	Matra Marconi	Communications			
4/29/98	Proton	Baikonur	Kosmos 2350	Russian MoD	Unknown	Military		S	S
5/2/98	v Long March 2C	Taiyuan	* Iridiums 69, 71	Iridium, Inc.	Lockheed Martin	Communications	\$20-25 M	S	S
5/7/98	Molniya	Plesetsk	Kosmos 2351	Russia	NPO Lavochkin	Classified		S	S
5/8/98	v Proton	Baikonur	* EchoStar 4	EchoStar Satellite Corp.	Lockheed Martin	Communications	\$75-95 M	S	S
5/8/98	Titan 4B/Centaur	CCAS	USA 139	DoD	Unknown	Classified		S	S
5/13/98	Titan 2	VAFB	NOAA 15	NOAA	Lockheed Martin	Meteorological		S	S
5/15/98	Soyuz	Baikonur	Progress M-39	RKK Energia	RKK Energia	Mir Re-supply		S	S
5/17/98	v † Delta 2 7920	VAFB	* Iridiums 70, 72-75	Iridium, Inc.	Lockheed Martin	Communications	\$45-55 M	S	S
5/30/98	Long March 3B	Xichang	ChinaStar 1A	Chinese Comm Ministry	Lockheed Martin	Communications		S	S
6/2/98	Shuttle Discovery	KSC	STS 91	NASA	Rockwell International	Crewed		S	S
6/9/98	v † Delta 2 7925	CCAS	* Thor 3	Telenor A.S.	Hughes	Communications	\$45-55 M	S	S
6/16/98	Cyclone 3	Plesetsk	Kosmos 2352-57	Russian MoD	NPO PM	Communications		P	S
6/18/98	v † Atlas 2AS	CCAS	* Intelsat 8A F5	Intelsat	Lockheed Martin	Communications	\$90-105 M	S	S
6/24/98	Soyuz	Plesetsk	Kosmos 2358	Russian MoD	Unknown	Military		S	S
6/25/98	Soyuz	Baikonur	Kosmos 2359	Russia MoD	Unknown	Military		S	S
7/1/98	Molniya	Plesetsk	Molniya 3	Russia PTT	NPO PM	Communications		S	S
7/4/98	M 5	Kagoshima	Nozomi	ISAS	NEC	Scientific		S	S
7/7/98	v Shtil	Submarine	Tubsat-N & N1	Berlin Technical Univ.	Berlin Technical Univ.	Communications	\$0.1-0.2 M	S	S
7/10/98	Zenit 2	Baikonur	Resurs-O1 N4	Russia	VNII Elektromekhaniki	Remote Sensing		S	S
			FASat-Bravo	Chilean Air Force	Surrey Sat. Tech. Ltd.	Remote Sensing			
			SAFIR 2	OHB System	OHB System	Communications			
			* TMSAT 1	Thai MicroSatellite Co.	Surrey Sat. Tech. Ltd.	Remote Sensing			
			WestPac	ElectroOptics Sys./RKA	Unknown	Remote Sensing			
			Tech Sat 2	Asher Space Res. Inst.	Technion Tech. Institute	Development			

v Denotes commercial launch, defined as a launch that is internationally competed or whose primary payload is commercial in nature.

† Denotes FAA-licensed launch.

* Denotes a commercial payload, defined as a spacecraft which serves a commercial function or is operated by a commercial entity.

L/M refers to the outcome of the launch and mission: S = success, P = partial success, F = failure.

1998 WORLDWIDE ORBITAL LAUNCH EVENTS (CONT.)

Date	Vehicle	Site	Payload	Operator	Manufacturer	Use	Coml Price	L	M
7/18/98	Long March 3B	Xichang	Sinosat 1	EuraSpace/Sinosatcom	Aerospatiale	Communications		S	S
7/28/98	Zenit 2	Baikonur	Kosmos 2360	Russian MoD	NPO Yuzhnoye	Intelligence		S	S
8/2/98	v † Pegasus XL/HAPS	Wallops	* Orbcomms 13-20	Orbcomm	Orbital (OSC)	Communications	\$12-15 M	S	S
8/12/98	Titan 4/Centaur	CCAS	USA 1998-08	DoD	Unknown	Classified		F	F
8/13/98	Soyuz	Baikonur	Soyuz TM-28	RKK Energia	RKK Energia	Crewed		S	S
8/20/98	v Long March 2C	Taiyuan	* Iridiums 76, 78	Iridium, Inc.	Lockheed Martin	Communications	\$20-25 M	S	S
8/25/98	v Ariane 44P	Kourou	* ST 1	Singapore Telecom	Matra Marconi	Communications	\$70-85 M	S	S
8/26/98	v † Delta 3	CCAS	* Galaxy 10	PanAmSat	Hughes	Communications	\$75-90 M	F	F
8/30/98	v Proton	Baikonur	* Astra 2A	SES	Hughes	Communications	\$75-95 M	S	S
8/31/98	Taepo Dong 1	Musudan-ri	Kwangmyongsong	North Korea	Unknown	Unknown		F	F
9/8/98	v † Delta 2 7920	VAFB	* Iridiums 77, 79-82	Iridium, Inc.	Lockheed Martin	Communications	\$45-55 M	S	S
9/10/98	v Zenit 2	Baikonur	* Globalstars 5, 7, 9-13, 16-20	Globalstar, Inc.	Space Systems/Loral	Communications	\$30-40 M	F	F
9/16/98	v Ariane 44LP	Kourou	* PAS 7	PanAmSat	Space Systems/Loral	Communications	\$80-95 M	S	S
9/23/98	v † Pegasus XL/HAPS	Wallops	* Orbcomms 21-28	Orbcomm	Orbital (OSC)	Communications	\$12-15 M	S	S
9/29/98	Molniya	Plesetsk	Molniya 1T-1998	Russia PTT	NPO PM	Communications		S	S
10/3/98	Taurus 1	VAFB	STEX	NRO	Lockheed Martin	Development		S	S
10/5/98	v Ariane 44L	Kourou	* Eutelsat W2	Eutelsat	Aerospatiale	Communications	\$90-110 M	S	S
			* Sirius 3	Nordiska Sat. (NSAB)	Hughes	Communications			
10/9/98	v † Atlas 2AS	CCAS	* Hot Bird 5	Eutelsat	Matra Marconi	Communications	\$90-105 M	S	S
10/20/98	† Atlas 2A	CCAS	GBS 9	DoD	Hughes	Communications	\$62-85 M	S	S
10/21/98	Ariane 5	Kourou	ARD	ESA	Aerospatiale	Development		S	S
			Maqsat 3	Kayser-Threde	Kayser-Threde	Test			
10/22/98	v † Pegasus 1	CCAS	SCD 2	INPE	INPE	Communications	\$10-14 M	S	S
10/24/98	Delta 2 7326	CCAS	Deep Space 1	NASA	Spectrum Astro, Inc.	Development		S	S
			Sedsat-1	NASA	Univ Alabama Huntsville	Communications			
10/25/98	Soyuz	Baikonur	Progress M-40	RKK Energia	RKK Energia	Mir Re-supply		S	S
			Sputnik 41	AMSAT France	AMSAT France	Communications			
10/28/98	v Ariane 44L	Kourou	* AfriStar 1	WorldSpace, Inc.	Alcatel Espace	Communications	\$90-110 M	S	S
			* GE 5	GE Americom	Aerospatiale	Communications			
10/29/98	Shuttle Discovery	KSC	STS 95	NASA	Rockwell International	Crewed		S	S
			Spartan 201-04R	NASA	NASA	Scientific			
			PANSAT 1	Naval Postgrad. School	Naval Postgrad. School	Communications			
11/4/98	v Proton	Baikonur	* PAS 8	PanAmSat	Space Systems/Loral	Communications	\$75-95 M	S	S
11/6/98	v † Delta 2 7920	VAFB	* Iridiums 83-87	Iridium, Inc.	Lockheed Martin	Communications	\$45-55 M	S	S
11/20/98	Proton	Baikonur	Zarya	International	Khrunichev	Space Station		S	S
11/22/98	v † Delta 2 7925	CCAS	* Bonum 1	Media Most	Hughes	Communications	\$45-55 M	S	S
12/4/98	Shuttle Endeavour	KSC	STS 88	NASA	Rockwell International	Crewed		S	S
			MightySat 1	DoD	Orbital (OSC)	Development			
			SAC A	NASA	Bariloché	Development			
			Unity	NASA	NASA	Space Station			
12/4/98	v Ariane 42L	Kourou	* SatMex 5	Telecomm Mexico	Hughes	Communications	\$75-90 M	S	S
12/5/98	Pegasus XL	VAFB	SWAS	Smithsonian Astro. Obs.	NASA	Scientific		S	S
12/10/98	Cosmos	Plesetsk	Nadezhda 5	Russia	NPO PM	Navigation		S	S
			Astrid 2	Swedish Natl Space Brd	Swedish Space Corp.	Scientific			
12/11/98	Delta 2 7425	CCAS	Mars Climate Orbiter	NASA	Lockheed Martin	Scientific		S	S
12/19/98	v Long March 2C	Taiyuan	* Iridiums 92, 93	Iridium, Inc.	Lockheed Martin	Communications	\$20-25 M	S	S
12/21/98	v Ariane 42L	Kourou	* PAS 6B	PanAmSat	Hughes	Communications	\$75-90 M	S	S
12/24/98	Cosmos	Plesetsk	Kosmos 2361	Russia	NPO Lavochkin	Navigation		S	S
12/30/98	Proton	Baikonur	Kosmos 2362-64	Russian MoD	NPO PM	Navigation		S	S

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